

**THE AMERICAN
ASSOCIATION
FOR LABORATORY
ACCREDITATION**

ACCREDITED LABORATORY

A2LA has accredited

**U.S. ARMY PRIMARY STANDARDS
LABORATORY
Redstone Arsenal, AL**

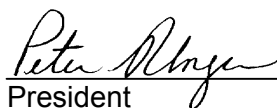
for technical competence in the field of

Calibration

The accreditation covers the specific calibrations listed on the agreed scope of accreditation. This laboratory meets the requirements of ISO/IEC 17025 - 1999 "General Requirements for the Competence of Testing and Calibration Laboratories" and any additional program requirements in the field of calibration. Laboratories that comply with this International Standard also operate in accordance with ISO 9001 or ISO 9002 (1994).

Presented this 11th day of March 2003.





President

For the Accreditation Council
Certificate Number 1256.01
Valid to December 31, 2004

For the calibrations to which this accreditation applies,
please refer to the laboratory's Calibration Scope of Accreditation.

SCOPE OF ACCREDITATION TO ISO/IEC 17025-1999

U.S. ARMY PRIMARY STANDARDS LABORATORY
AMSAM-TMD-S
Redstone Arsenal, AL 35898-5000
John Ball Phone: 256 876 2666

CALIBRATION

Valid To: December 31, 2004

Certificate Number: 1256.01

In recognition of the successful completion of the A2LA evaluation process, accreditation is granted to this laboratory to perform the following calibrations:

I. Electrical – DC/Low Frequency

Parameter	Range	Best Uncertainty ¹ (\pm)	Comments
DC Voltage	1 V	0.1 ppm	Josephson Array system
	10 V	0.04 ppm	
	(0 to 220) mV	7.5 ppm + 0.4 μ V	Fluke 5720 and HP 3458A (option 2)
	(220 to 2.2) V	5.0 ppm + 0.7 μ V	
	(2.2 to 11) V	3.5 ppm + 2.5 μ V	
	(11 to 22) V	3.5 ppm + 4.0 μ V	
	(22 to 220) V	5.0 ppm + 40 μ V	
	(220 to 1000) V	6.5 ppm + 400 μ V	
DC Resistance	(1 to 10) m Ω	4.3 ppm	Direct comparison with current comparator using an MI 6010B and 6000A
	(10 to 100) m Ω	3.6 ppm	
	(0.1 to 1) Ω	0.85 ppm	
	(1 to 10) Ω	0.37 ppm	
	(10 to 100) Ω	0.65 ppm	
	(0.1 to 1) k Ω	0.71 ppm	
	(1 to 10) k Ω	1.0 ppm	
	(10 to 100) k Ω	2.8 ppm	
	(0.1 to 1) M Ω	3.8 ppm	
	10 M Ω	0.04 %	Penn Airborne resistors with Guildline 6500
	100 M Ω	0.04 %	
	1 G Ω	0.10 %	
	10 G Ω	0.10 %	
	100 G Ω	0.22 %	
	1 T Ω	0.25 %	

Parameter	Range	Best Uncertainty ¹ (±)	Comments
Inductance	0.1 mH 1 mH 10 mH 100 mH 1 H 10 H	0.11 % 0.031 % 0.028 % 0.022 % 0.011 % 0.20 %	Comparison with reference standards using General Radio RLC Digibridge
Capacitance	10 pF 100 pF 1000 pF	13 ppm 29 ppm 29 ppm	Comparison to reference standards using Andeen-Hagerling 2500A
AC Ratio	400 Hz and 1 kHz	0.5 ppm	Ratio techniques
Risetime	> 15 ps Tr	9 ps	Comparison w/standard pulse generators using digital sampling system
VOR Bearing Angle	0° 30° to 330°	0.01° 0.02°	Comparison with NIST VOR standard using NIST automated system
Current Ratio and Phase – 2:1, 4:1, 5:1, 10:1, 20:1	60 Hz	0.0025 % (ratio) 0.9' (phase)	Current transformer technique ESL-5: current ratio technique using Guildline 9900
AC/DC Difference Current Shunts 10 mA to 5 A 10 A	10 KHz 10 KHz	100 ppm 200 ppm	Current shunt technique ESL-16: direct comparison with NIST calibrated current shunt standards

Parameter	Range	Best Uncertainty ¹ (±)	Comments
AC/DC Difference – Voltage			AC voltage measurement technique ESL-7: intercomparison with NIST TVC using a Fluke 5720, 5725 and 5215
0.5 V	(10 to 20) Hz (20 to 50) Hz (50 to 400) Hz 400 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 500) kHz 500 kHz to 1 MHz	22 ppm 13 ppm 10 ppm 14 ppm 18 ppm 37 ppm 84 ppm 130 ppm	
1 V	(10 to 20) Hz (20 to 50) Hz (50 to 400) Hz 400 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 500) kHz 500 kHz to 1 MHz	16 ppm 11 ppm 11 ppm 24 ppm 20 ppm 16 ppm 97 ppm 110 ppm	
2 V	(10 to 20) Hz (20 to 50) Hz (50 to 400) Hz 400 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 500) kHz 500 kHz to 1 MHz	11 ppm 11 ppm 8 ppm 11 ppm 9 ppm 11 ppm 72 ppm 73 ppm	
3 V	(10 to 20) Hz (20 to 50) Hz (50 to 400) Hz 400 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 500) kHz 500 kHz to 1 MHz	12 ppm 11 ppm 8 ppm 6 ppm 9 ppm 14 ppm 75 ppm 99 ppm	
6 V	(10 to 20) Hz (20 to 50) Hz (50 to 400) Hz 400 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 500) kHz 500 kHz to 1 MHz	12 ppm 14 ppm 12 ppm 11 ppm 11 ppm 15 ppm 72 ppm 300 ppm	

Parameter	Range	Best Uncertainty ¹ (±)	Comments
AC/DC Difference – Voltage (cont)			AC voltage measurement technique ESL-7: intercomparison with NIST TVC using a Fluke 5720, 5725 and 5215
10 V	(10 to 20) Hz (20 to 50) Hz (50 to 400) Hz 400 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 500) kHz 500 kHz to 1 MHz	12 ppm 12 ppm 9 ppm 6 ppm 10 ppm 16 ppm 94 ppm 140 ppm	
20 V	(10 to 20) Hz (20 to 50) Hz (50 to 400) Hz 400 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 500) kHz 500 kHz to 1 MHz	22 ppm 19 ppm 14 ppm 11 ppm 9 ppm 18 ppm 150 ppm 240 ppm	
30 V	(10 to 20) Hz (20 to 50) Hz (50 to 400) Hz 400 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz	13 ppm 11 ppm 7 ppm 7 ppm 15 ppm 28 ppm	
60 V	(10 to 20) Hz (20 to 50) Hz (50 to 400) Hz 400 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz	16 ppm 14 ppm 12 ppm 19 ppm 17 ppm 28 ppm	
100 V	(10 to 20) Hz (20 to 50) Hz (50 to 400) Hz 400 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz	15 ppm 13 ppm 11 ppm 9 ppm 14 ppm 71 ppm	
200 V	(10 to 20) Hz (20 to 50) Hz (50 to 400) Hz 400 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz	17 ppm 18 ppm 9 ppm 9 ppm 14 ppm 30 ppm	

Parameter	Range	Best Uncertainty ¹ (±)	Comments
AC/DC Difference – Voltage (cont)			AC voltage measurement technique ESL-7: intercomparison with NIST TVC using a Fluke 5720, 5725 and 5215
300 V	(20 to 50) Hz (50 to 400) Hz 400 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz	21 ppm 23 ppm 12 ppm 16 ppm 30 ppm	
600 V	(20 to 50) Hz (50 to 400) Hz 400 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz	23 ppm 22 ppm 14 ppm 19 ppm 28 ppm	
950 V	50 Hz (50 to 400) Hz 400 Hz to 20 kHz	31 ppm 38 ppm 61 ppm	
AC/DC Difference – Voltage (0.45 to 30) V	1 MHz 3 MHz 10 MHz 30 MHz 100 MHz	230 ppm 240 ppm 520 ppm 0.14 % 1.4 %	AC voltage measurement technique ESL-29: intercomparison with NIST TVC using a Fluke 5720 and 6060B

II. Time and Frequency

Parameter/Equipment	Range	Best Uncertainty ¹ (±)	Comments
Frequency	0.1 MHz, 1 MHz, 5 MHz, 10 MHz	1 part in 10^{12}	Direct comparison w/master oscillator using NIST-developed frequency measurement technique
Frequency Counters – Band and Frequency (as required)	To 110 GHz	0.1 ppm	Comparison with master oscillators

III. Electrical/EMC – High Frequency

Parameter/Equipment	Range	Best Uncertainty ¹ (±)
<p>RF Power</p> <p>Calibration Factor:</p> <p>Coaxial type N connector Coaxial 3.5 mm connector Coaxial 2.92 mm (K) connector</p> <p>X band (WR-90) waveguide Ku band (WR-62) waveguide K band (WR-42) waveguide Ka band (WR-28) waveguide Q band (WR-22) waveguide V band (WR-15) waveguide W band (WR-10) waveguide</p> <p>Technique: Power ratio comparison with standard thermistor mounts.</p>	<p>(0.1 to 10) mW; (0.0001 to 18) GHz (0.1 to 10) mW; (0.01 to 26.5) GHz (0.1 to 10) mW; (0.01 to 40.0) GHz</p> <p>(0.1 to 10) mW; (8.2 to 12.4) GHz (0.1 to 10) mW; (12.4 to 18.0) GHz (0.1 to 10) mW; (18.0 to 26.5) GHz (0.1 to 10) mW; (26.5 to 40.0) GHz (0.1 to 4) mW; (43.0 to 45.0) GHz (0.1 to 1) mW; (58.0 to 62.0) GHz (0.1 to 3) mW; (93.0 to 96.0) GHz</p>	<p>0.7 % to 1.0 % 1.8 % to 1.9 % 2.2 % to 3.5 %</p> <p>1.5 % 1.5 % 1.6 % 1.4 % 2.4 % 1.6 % 2.4 %</p>
<p>Pulsed Power</p> <p>Coaxial type N connector</p> <p>Technique: Power ratio comparison with standard thermistor mounts.</p>	<p>(0.1 to 10) mW peak power; (0.01 to 18.0) GHz</p>	<p>(0.06 to 0.35) dB</p>
<p>RF Wattmeters</p> <p>Terminating – Coaxial with type N connectors Coaxial with 14 mm connectors</p> <p>Thru-line – Coaxial with type N connectors Coaxial with 14 mm connectors</p> <p>Technique: Power ratio comparison w/standard thermistor mounts using an automated Brammal cascaded ratio technique</p>	<p>(1 to 180) W; (0.4 to 1000) MHz (1 to 180) W; (0.4 to 1000) MHz</p> <p>(1 to 180) W; (0.4 to 1000) MHz (1 to 180) W; (0.4 to 1000) MHz</p>	<p>2.0 % 2.0 %</p> <p>1.2 % 1.2 %</p>

Parameter/Equipment	Range	Best Uncertainty ¹ (\pm)
<p>Thermal Noise</p> <p>Coaxial type N connector Coaxial 3.5 mm connector</p> <p>Technique: Ratio comparison with standard noise sources</p>	<p>(5 to 40) dB ENR; (0.03 to 18) GHz (5 to 40) dB ENR; (0.03 to 26.5) GHz</p>	<p>(0.2 to 0.4) dB (0.3 to 0.7) dB</p>
<p>Power Ratio</p> <p>Coaxial type N, 7 mm, 14 mm connector</p> <p>Technique: Power ratio, Brammall cascaded power ratio</p>	<p>(0 to 50) dB; (0.0003 to 1.0) GHz</p>	<p>1.0 % of ratio</p>
<p>Reflection Measurements</p> <p>S_{11} Magnitude:</p> <p>Coaxial type N connector Coaxial 14 mm connector Coaxial 7 mm connector Coaxial 3.5 mm connector Coaxial 2.4 mm connector Coaxial 2.92 mm (K) connector</p> <p>X band WR-90 waveguide Ku band WR-62 waveguide K band WR-42 waveguide Ka band WR-28 waveguide</p> <p>S_{11} Phase:</p> <p>Coaxial type N connector Coaxial 7 mm connector Coaxial 3.5 mm connector Coaxial 2.4 mm connector Coaxial 2.92 mm (K) connector</p> <p>X band WR-90 waveguide Ku band WR-62 waveguide K band WR-42 waveguide Ka band WR-28 waveguide</p>	<p>0.02 to 0.6; (0.01 to 18.0) GHz 0.02 to 0.6; (0.01 to 8.0) GHz 0.02 to 0.6; (0.01 to 18.0) GHz 0.02 to 0.6; (0.01 to 26.5) GHz 0.02 to 0.6; (0.01 to 40.0) GHz 0.02 to 0.6; (0.01 to 40.0) GHz</p> <p>0.02 to 0.6; (8.2 to 12.4) GHz 0.02 to 0.6; (12.4 to 18.0) GHz 0.02 to 0.6; (18.0 to 26.5) GHz 0.02 to 0.6; (26.5 to 40.0) GHz</p> <p>0° to 360°; (0.01 to 18.0) GHz 0° to 360°; (0.01 to 18.0) GHz 0° to 360°; (0.01 to 26.5) GHz 0° to 360°; (0.01 to 40.0) GHz 0° to 360°; (0.01 to 40.0) GHz</p> <p>0° to 360°; (8.2 to 12.4) GHz 0° to 360°; (12.4 to 18.0) GHz 0° to 360°; (18.0 to 26.5) GHz 0° to 360°; (26.5 to 40.0) GHz</p>	<p>Techniques: Reflectometer, network analyzer, 6-port</p> <p>0.005 to 0.015 0.005 to 0.015 0.005 to 0.020 0.010 to 0.030 0.010 to 0.030 0.010 to 0.030</p> <p>0.006 0.006 0.01 0.01</p> <p>Techniques: Network analyzer, 6-port</p> <p>0.5° to 180° 0.5° to 180° 0.5° to 180° 0.5° to 180° 0.5° to 180°</p> <p>0.6° to 180° 0.6° to 180° 0.6° to 180° 0.6° to 180°</p>

Parameter/Equipment	Range	Best Uncertainty ¹ (±)
Attenuation Measurements		
Incremental Attenuation	(0 to 120) dB; 30 MHz	0.003 dB/10 dB Technique: NIST 30 MHz attenuation measurement system
S ₂₁ Magnitude:		Technique: Reflectometer, network analyzer, dual 6-port
Coaxial type N connector	(0 to 60) dB; (0.01 to 18.0) GHz	(0.07 to 0.6) dB
Coaxial 7 mm connector	(0 to 60) dB; (0.01 to 18.0) GHz	(0.06 to 0.5) dB
Coaxial 3.5 mm connector	(0 to 50) dB; (0.01 to 26.5) GHz	(0.15 to 1.0) dB
Coaxial 2.4 mm connector	(0 to 50) dB; (0.01 to 50.0) GHz	(0.15 to 1.0) dB
Coaxial 2.92 mm (K) connector	(0 to 50) dB; (0.01 to 40.0) GHz	(0.06 to 1.0) dB
X band WR-90 waveguide	(0 to 50) dB; (8.2 to 12.4) GHz	(0.042 to 0.17) dB
Ku band WR-62 waveguide	(0 to 50) dB; (12.4 to 18.0) GHz	(0.042 to 0.17) dB
K band WR-42 waveguide	(0 to 40) dB; (18.0 to 26.5) GHz	(0.042 to 0.17) dB
Ka band WR-28 waveguide	(0 to 40) dB; (26.5 to 40.0) GHz	(0.042 to 0.17) dB
S ₂₁ Phase:		
Coaxial type N connector	0° to 360°; (0.01 to 18.0) GHz	0.2° to 20°
Coaxial 7 mm connector	0° to 360°; (0.01 to 18.0) GHz	0.2° to 20°
Coaxial 3.5 mm connector	0° to 360°; (0.01 to 26.5) GHz	0.2° to 20°
Coaxial 2.4 mm connector	0° to 360°; (0.01 to 40.0) GHz	0.2° to 20°
Coaxial 2.92 mm (K) connector	0° to 360°; (0.01 to 40.0) GHz	0.2° to 20°
X band WR-90 waveguide	0° to 360°; (8.2 to 12.4) GHz	0.2° to 20°
Ku band WR-62 waveguide	0° to 360°; (12.4 to 18.0) GHz	0.2° to 20°
K band WR-42 waveguide	0° to 360°; (18.0 to 26.5) GHz	0.2° to 20°
Ka band WR-28 waveguide	0° to 360°; (26.5 to 40.0) GHz	0.2° to 20°
Electromagnetic Field Strength	(20 to 62) V/m; (0.0003 to 45.0) GHz	2.0 dB
Electromagnetic Power Density (Hazard Probes, Meters)	(0.1 to 1.0) mW/cm ² ; (0.0003 to 45.0) GHz	2.0 dB
Technique: Anechoic chamber, TEM cell		

IV. Dimensional

Parameter/Equipment	Range	Best Uncertainty ¹ (±)	Comments
Gage Blocks	(0.01 to 1) in (2 to 20) in	4 µin (3.3 + 1.5L) µin	Mechanical comparison
Thread and Gear Wires	(4 to 80) pitch	20 µin	Mechanical comparison
Precision Balls	To 1 in	20 µin	Mechanical comparison
Angle Blocks	1' to 45°	1 arc second	Autocollimator/ comparison to master angle block
Flatness	Up to 3 in diameter (3 to 5) in diameter	2 µin 3 µin	Interferometer/master optical flat

V. Mechanical

Parameter/Equipment	Range	Best Uncertainty ¹ (±)	Comments
Mass	1 mg 2 mg 3 mg 5 mg 10 mg 20 mg 30 mg 50 mg 100 mg 200 mg 300 mg 500 mg 1 g 2 g 3 g 5 g 10 g 20 g 30 g 50 g	0.37 µg 0.30 µg 0.41 µg 0.51 µg 0.48 µg 0.42 µg 0.45 µg 1.0 µg 0.51 µg 0.71 µg 0.72 µg 1.3 µg 1.8 µg 3.2 µg 4.5 µg 7.4 µg 15 µg 12 µg 15 µg 24 µg	By comparison to precision single pan balance

Parameter/Equipment	Range	Best Uncertainty ¹ (±)	Comments
Mass (cont)	100 g 200 g 300 g 500 g 1000 g 2 kg 5 kg 10 kg 20 kg 0.001 lb 0.002 lb 0.003 lb 0.005 lb 0.01 lb 0.02 lb 0.03 lb 0.05 lb 0.1 lb 0.2 lb 0.3 lb 0.5 lb 1 lb 2 lb 5 lb 10 lb 20 lb 25 lb 30 lb 50 lb	35 µg 53 µg 67 µg 78 µg 0.21 mg 0.52 mg 1.4 mg 2.7 mg 18 mg 0.98 µg 0.23 µg 0.56 µg 0.57 µg 12 µg 12 µg 15 µg 59 µg 26 µg 35 µg 56 µg 83 µg 82 µg 0.28 mg 0.61 mg 2.7 mg 1.3 mg 24 mg 25 mg 45 mg	By comparison to Class 1 Type 2 standard weights, using precision single pan balance
Force – Load Cells, Proving Rings, etc.	(10 to 1000) lb (20 000 to 1 000 000) lb	0.01 % 0.05 %	Deadweight force machine Morehouse force machine
Torque Cells	To 3000 lb·ft To 20 000 lb·ft	0.1 % 0.3 %	Torque calibration Lebow deadweight floating system
Accelerometry	4 Hz to 2 kHz (2 to 100) g's (3 to 10) kHz (2 to 100) g's	1.5 % 2.5 %	Comparison calibration G is the standard acceleration due to gravity. ($g = 9.8 \text{ m/s}^2$)

Parameter/Equipment	Range	Best Uncertainty ¹ (±)	Comments
Rate Calibration	± 500 °/sec	1.6 %	Frequency counter and DMM
Pressure – Mercurial Manometer, Piston Gages, Piston Gages (medium)	To 100 inHg (0.5 to 1000) psi (600 to 12 000) psi	0.0003 in Hg + 0.0021 % of reading 0.008 % 0.010 %	Schwein mercurial manometer Deadweight piston gage
Vacuum	(20 to 5x10 ⁻³) torr	0.7 % of reading	MKS

VI. Acoustical Quantities

Parameter	Range	Best Uncertainty ¹ (±)	Comments
Microphone Sensors	20 Hz to 1 kHz (2 to 7) kHz (8 to 12.5) kHz	0.1 dB 0.15 dB 0.3 dB	Type L pressure reciprocity
	250 Hz 2 Hz to 200 kHz 100 Hz to 20 kHz	1 dB 0.08 dB 0.8 dB	Voltage insertion Electrostatic actuator Plane wave tube
Sound Calibrators	125 Hz to 4 kHz	0.3 dB	Comparison to APSL calibrated standard sound calibrator
	20 Hz to 25 kHz	0.9 dB	Voltage insertion
Artificial Mastoids	1 kHz	4.5 %	Impedance head used as transfer standard

VII. Fluid Quantities

Parameter/Equipment	Range	Best Uncertainty ¹ (±)	Comments
Gas Mask Tester Calibration	1000 to 10 000 particles per cc	20 % fit factor	Aerosol measurement and comparison to CNC
Calibration of Air and Gas Flow Meters	(1 to 30) cfm 10 ccpm to 50 ltr/min	1 % 0.75 % of reading	Bell Prover (air) MoBloc calibration system

VIII. Optical Quantities

Parameter	Range	Best Uncertainty ¹ (±)	Comments
Fiber Optics Power – 10 nW to 100 µW	850 nm 1310 nm 1550 nm	3.0 % 3.0 % 3.0 %	Detector based
Fiber Optics Wavelength	(600 to 1700) nm	0.5 nm	Spectrum analyzer and intrinsic source
Spectral radiance – (300 to 1600) nm	(1×10^{-9} to 1×10^{-5}) $\text{Wcm}^{-2}\text{sr}^{-1}\text{nm}^{-1}$	5 %	Detector and source based
Spectral Transmission – (300 to 1500) nm	0 % to 100 %	3 %	Spectrophotometer
Photometric – Illuminance Luminance Color Temperature	(10 to 500) fcd (10 to 10 000) fL 2000 K to 3200 K	2 % 2 % 17 K	Detector and source based

Parameter/Equipment	Range	Best Uncertainty ¹ (±)	Comments
Laser Energy (1064 nm)	200 nJ to 20 mJ	7 %	Detector based and using beamsplitters
Laser Power			Detector based and using beamsplitters
488 nm	100 mW to 1 W	5 %	
514.5 nm	100 mW to 1 W	5 %	
1064 nm	100 mW to 8 W	5 %	
UV Irradiance (365 nm)	(600 to 2000) W/cm ²	10 %	Detector based

IX. Thermodynamics

Parameter/Equipment	Range	Best Uncertainty ¹ (±)	Comments
Humidity	10 % to 90 %	0.5 %	Two-pressure chamber
Standard Platinum Resistance Thermometers – Fixed Point Calibrations:	-189 °C to 962 °C		
Triple Point of Water	0.01 °C	0.0010 °C	Triple points and freezing points using ac bridge
Triple Point of Ar:	-189.3442 °C	0.0025 °C	
Triple Point of Hg:	38.8344 °C	0.0017 °C	
Melting Point of Ga	29.7646 °C	0.0018 °C	
Freeze Point of Sn	231.928 °C	0.0026 °C	
Freeze Point of Zn	419.527 °C	0.0038 °C	
Non-fixed Point Calibration of Temperature Devices Using SPRT	-60 °C to 350 °C	0.008 °C	Direct comparison in baths

Parameter/Equipment	Range	Best Uncertainty ¹ (±)	Comments
Thermocouples – Type S Type K Type J Type T Other Types	0 °C to 1000 °C 0 °C to 1000 °C 0 °C to 750 °C 0 °C to 350 °C 0 °C to 1000 °C	0.75 °C 3 °C 3 °C 1.5 °C 5 °C	Direct comparison
Blackbody Radiation Temperature	10 °C to 1000 °C	2.2 °C	Direct comparison

X. Ionizing Radiation and Radioactivity

Parameter	Range	Best Uncertainty ¹ (±)	Comments
Alpha Sources	Small area (²³⁹ Pu) To 1x10 ⁷ CPM Large area (²³⁸ Pu, ²³⁹ Pu) To 1x10 ⁶ BQ	4.0 % 5.0 %	Source and detector based
Gamma Sources ² (¹³⁷ Cs, ⁶⁰ Co)	0.05 mR/hr to 5000 R/hr	3.5 %	Detector based
X-Ray Source (20 to 250 keV)	(0.5 to 500) R/hr	3.5 %	Detector based
Gamma Detectors (20 to 250 keV)	0.05 mR/hr to 800 R/hr	10 %	Source based
X-Ray Detectors	(0.5 to 500) R/hr	10 %	Source based

¹ Best Uncertainties represent expanded uncertainties using a coverage factor of $k=2$ which provides a level of confidence of approximately 95 %.

² On-Site calibration service is available for this calibration. The uncertainties achievable on a customer's site can be expected to be larger than the Best Measurement Capabilities (BMC) that the accredited laboratory has been assigned as Best Uncertainty on the A2LA Scope. Allowance must be made for aspects such as the environment at the place of calibration and for other possible adverse effects such as those caused by transportation of the calibration equipment. The usual allowance for the uncertainty introduced by the item being calibrated, (e.g. resolution) must also be considered and this, on its own, could result in the calibration uncertainty being larger than the BMC.